

## SUMMER HABITAT USE AND SELECTION BY FEMALE SAGE GROUSE (*CENTROCERCUS UROPHASIANUS*) IN OREGON

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**ABSTRACT.**—Cover types and vegetative characteristics (e.g., grasses, forbs, shrubs) used by female Sage Grouse (*Centrocercus urophasianus*) during summer were compared with available habitat on two study areas in southeastern Oregon. Broodless hens, which constituted 114 of the 125 (91%) radio-marked hens studied, selected big (*Artemisia tridentata* subsp.) and low sagebrush (*A. arbuscula*) cover types at both study areas. At Hart Mountain, broodless hens did not select specific vegetative characteristics within cover types. However, at Jackass Creek, forb cover was greater ( $P = .004$ ) at broodless hen sites than at random locations. Differences in habitat use by broodless hens between study areas were associated with differences in forb availability. Broodless hens used a greater diversity of cover types than hens with broods. Broodless hens gathered in flocks and remained separate from but near hens with broods during early summer. By early July broodless hens moved to meadows while hens with broods remained in upland habitats.

*Key words:* Sage Grouse, *Centrocercus urophasianus*, Oregon, female, broodless hens, habitat, movements, summer, broods, use, selection.

Productivity of Sage Grouse (*Centrocercus urophasianus*) is among the lowest of North American grouse (Edminster 1954:130). Reported nest failure ranged from 76% in Oregon (Batterson and Morse 1948) to 36% (Wallestad and Pyrah 1974) in Montana. Consequently, a relatively large percentage of summer Sage Grouse populations consists of broodless hens. However, information on broodless hens is largely anecdotal. Only observations of the proximity of broodless hens to hens with broods (Dalke et al. 1963, Martin 1976) and chronology of summer movements by broodless hens (Petersen 1980, Connelly et al. 1988) have been reported. No study has dealt specifically with habitat use by broodless Sage Grouse.

We investigated habitat use by broodless hens on a hierarchical order of selection (Johnson 1980). We hypothesized that broodless Sage Grouse selected cover types (third-order selection) and vegetative characteristics within cover types (fourth-order selection) and that selection differed between broodless hens and hens with broods. Our objectives were to identify cover types used by broodless hens in relation to availability; to identify vegetative characteristics at broodless hen sites and compare those to randomly selected loca-

tions, and to assess habitat use by broodless hens in relation to hens with broods on two study areas.

### STUDY AREAS

The study areas were located in southeastern Oregon at Hart Mountain National Antelope Refuge (Lake County) and at Jackass Creek (Harney County). Topography at both areas consists of flat sagebrush plains interrupted by rolling hills, ridges, and draws. Elevations range from 1500 to 2450 m at Hart Mountain and from 1200 to 1700 m at Jackass Creek. Vegetation at both areas is dominated by low sagebrush (*Artemisia arbuscula*), big sagebrush (*A. tridentata vaseyana*, *A. t. wyomingensis*, and *A. t. tridentata*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and western juniper (*Juniperus occidentalis*). Stands of curl-leaf mountain-mahogany (*Cercocarpus ledifolius*) and quaking aspen (*Populus tremuloides*) occur only at Hart Mountain. Common annual and perennial forbs include mountain-dandelion (*Agoseris* spp.), milk-vetch (*Astragalus* spp.), hawksbeard (*Crepis* spp.), lupine (*Lupinus* spp.), and phlox (*Phlox* spp.). Grasses consist largely of bluegrass (*Poa* spp.), bluebunch wheatgrass (*Agropyron*

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*spicatum*), needlegrass (*Stipa* spp.), fescue (*Festuca* spp.), giant wildrye (*Elymus cinereus*), and bottlebrush squirreltail (*Sitauion hystrix*). Plant nomenclature from Hitchcock and Cronquist (1957) was used.

#### METHODS

Female Sage Grouse were captured (Giesen et al. 1982) during summer 1988, spring and summer 1989–90, and spring 1991. Each hen was fitted with a numbered aluminum leg band and a poncho-mounted, solar-powered radio transmitter with a nickel-cadmium battery (Amstrup 1980). Radio-marked hens were monitored during summer (June–August) 1989–91 at an average rate of no more than twice monthly to minimize the problem associated with lack of independence of locations. Furthermore, we recaptured and removed radios from hens at the conclusion of each field season, and previously unmarked hens were fitted with radios for use in subsequent years to maintain independence of samples among years. Nevertheless, we acknowledge there may be a potential bias in the use of re-observations, even at a low rate of frequency, of the same individuals within a breeding season.

All locations of radio-marked hens were mapped as Universal Transverse Mercator coordinates. Visual locations of radio-marked broodless hens were marked and served as sites for vegetation sampling during June and July 1990. Date, location, and flock size of broodless hens and hens with broods observed on each study area were recorded. Definitions of monthly time periods were early (first 10 days), mid (middle 10 days), and late (last 10 days).

Eleven cover types were defined on the basis of dominant shrubs and grasses (Gregg 1992). We used color infrared aerial photographs and topographic maps to delineate cover types on each study area. Each hen location was classified into 1 of the 11 cover types. At each study area available habitat was determined with the minimum convex polygon method (Odum and Kuenzler 1955) from telemetry locations obtained during summer. Proportions of cover types within the available habitat at each area were determined with a dot grid system (Avery 1977).

We characterized vegetation at sites used by broodless hens within two days after visual locations were determined. Canopy cover (%) of shrubs was measured by line intercept (Canfield 1941) along two 10-m perpendicular transects intersecting at the broodless hen site. The position of the first transect was determined from a randomly selected compass bearing. Each shrub intercepted was placed into one of three height classes: short (<40 cm), medium (40–80 cm), or tall (>80 cm). Canopy cover of shrubs was recorded separately for each height class. Cover (%) of forbs and grasses was estimated in five 20 × 50-cm plots equidistantly spaced along each transect (Daubenmire 1959). Vegetation was characterized at randomly located points during June and July with the same methods used to measure variables at broodless hen sites. Random sites were located with a random numbers table, which was used to determine starting point, compass bearing, and distance traveled.

We compared the use of cover types by broodless hens with availability of cover types within study areas from June through August. The proportions of cover types available were used to establish the expected values for frequency of bird observations occurring in those cover types. We also compared cover type use between broodless hens and hens with broods. Chi-square analysis was used for these tests. Cover types with expected values of <5 bird observations were combined and analyzed collectively. If differences were detected, confidence intervals were calculated to identify cover types that contributed to the difference (Neu et al. 1974, Byers et al. 1984).

We used a factorial analysis of variance (ANOVA) (PROC GLM, SAS Institute, Inc. 1989) to compare vegetative characteristics among plot types (broodless hen or random). Study area was an additional factor in the ANOVA model to account for variation associated with spatial differences (Snedecor and Cochran 1967:339). A significant plot type (hen use site or random location) × study area interaction ( $P = .02$ ) was detected for forb cover. Consequently, differences among plot types for forb cover were reported by study area. A single-factor ANOVA was used to compare vegetative characteristics at random locations between study areas in cover types used by broodless hens. We assumed our data

TABLE 1. Use (%) of cover types during summer (June–August) by radio-marked broodless Sage Grouse hens at Hart Mountain National Antelope Refuge ( $n = 67$  hens, 168 locations) and Jackass Creek ( $n = 47$  hens, 137 locations) study areas, Lake and Harney counties, Oregon, 1989–91.

Cover type	Hart Mountain			Jackass Creek		
	% avail	% use	$\chi^2$	% avail	% use	$\chi^2$
Low sagebrush/bunchgrass	44	30	7.1*	37	18	11.0*
Wyoming big sagebrush	0	0		41	36	0.9
Mountain big sagebrush	20	34	16.3*	0	0	
Mixed sagebrush	0	0		11	39	95.5*
Grassland	12	8	1.9	0	0	
Low sagebrush/fescue	5	15	36.9*	0	0	
Meadow	3	10	23.8*	0	0	
Other <sup>a</sup>	16	2	19.5*	11	5	1.1

<sup>a</sup>Includes basin big sagebrush, lakebed, and mountain shrub.

\*Use differed ( $P < .05$ ) from availability.

were normally distributed (PROC UNIVARIATE, SAS Institute, Inc. 1989), and we considered our results significant if  $P \leq .05$ .

## RESULTS

One hundred fourteen radio-marked broodless hens (67 at Hart Mountain and 47 at Jackass Creek) were relocated 305 times (168 locations at Hart Mountain and 137 locations at Jackass Creek). Seven radio-marked hens with broods at Hart Mountain were relocated 90 times, and 4 radio-marked hens at Jackass Creek were relocated 55 times during the same time period. Available habitat encompassed 393 km<sup>2</sup> at Hart Mountain and 563 km<sup>2</sup> at Jackass Creek. Vegetative characteristics were measured at 112 broodless hen sites (22 and 90 at Hart Mountain and Jackass Creek, respectively) and 100 random locations (30 at Hart Mountain and 70 at Jackass Creek).

Small flocks of broodless hens (2–3 birds) were first observed during mid-May at both study areas. By early June, flocks of as many as 25 broodless hens were commonly found in low sagebrush, big sagebrush, and mixed sagebrush (mosaic of low and big sagebrush) cover types. Broodless hens remained near hens with broods until early July and then moved to meadows. Numbers of broodless hens in meadows increased until by late July flocks of >100, which potentially may have contained some early hatched young birds, were observed. Typically, however, hens with broods remained in sagebrush upland habitats until early August and then moved to meadows and joined broodless hens.

Broodless hens used mountain big sagebrush, low sagebrush/fescue, and meadow

habitats at Hart Mountain and mixed sagebrush at Jackass Creek more frequently ( $P < .05$ ) than expected, based on availability (Table 1). Low sagebrush/bunchgrass was used less frequently ( $P < .05$ ) than expected at both study areas (Table 1). Cover-type use differed ( $P < .05$ ) between broodless hens and hens with broods. Broodless hens used less low sagebrush/fescue and more low sagebrush/bunchgrass, grassland, and meadow than hens with broods at Hart Mountain and used more mixed sagebrush than hens with broods at Jackass Creek (Table 2).

At Jackass Creek forb cover (%) was greater ( $P = .004$ ) at broodless hen sites ( $\bar{x} = 4$ ,  $SD = 4$ ,  $n = 90$ ) than at random locations ( $\bar{x} = 2$ ,  $SD = 3$ ,  $n = 70$ ). However, at Hart Mountain forb cover did not differ ( $P = .37$ ) between broodless hen ( $\bar{x} = 10$ ,  $SD = 6$ ,  $n = 22$ ) and random ( $\bar{x} = 12$ ,  $SD = 9$ ,  $n = 30$ ) sites. No differences ( $P > .05$ ) in other habitat characteristics were detected between broodless hen and random locations (Table 3). Cover of forbs, grasses, and short shrubs was greater and tall shrubs was less ( $P < .05$ ) in cover types used at Hart Mountain than at Jackass Creek (Table 4). Differences in canopy cover of short and tall shrubs between study areas reflected cover types used by broodless hens at the two areas. Canopy cover of all height classes of shrubs combined was similar between areas (26% and 25% at Hart Mountain and Jackass Creek, respectively).

## DISCUSSION

Differences in habitat use by broodless hens between study areas were attributed to differences in forb availability. Forbs are an

TABLE 2. Use (%) of cover types during summer (June–August) by radio-marked female Sage Grouse at Hart Mountain National Antelope Refuge and Jackass Creek study areas, Lake and Harney counties, Oregon, 1989–91.

Cover type	Hart Mountain			Jackass Creek		
	Broodless (67/168) <sup>a</sup>	Brood (7/94)	$\chi^2$	Broodless (47/137)	Brood (4/55)	$\chi^2$
Low sagebrush bunchgrass	30*	6	151.3*	18	24	2.2
Wyoming big sagebrush	0	0		36	42	1.2
Mountain big sagebrush	34	40	1.75	0	0	
Mixed sagebrush	0	0		39*	22	17.9*
Grassland	8*	1	54.5*	0	0	
Low sagebrush fescue	15*	49	35.4*	0	0	
Meadow	10*	3	21.1*	0	0	
Other <sup>b</sup>	2	0		8	13	2.4

<sup>a</sup>Sample size indicated by numbers within parentheses (number of hens/number of locations).

<sup>b</sup>Includes basin big sagebrush, lakebed, and mountain shrub.

\*Use differed ( $P < .05$ ) between broodless hens and hens with broods.

TABLE 3. Vegetative characteristics (% cover) at sites used by radio-marked broodless Sage Grouse hens and random locations at Hart Mountain National Antelope Refuge and Jackass Creek study areas, Lake and Harney counties, Oregon, June and July 1990.

Characteristic	<i>P</i> value	Broodless hen sites ( <i>n</i> = 112)		Random sites ( <i>n</i> = 100)	
		$\bar{x}$	SD	$\bar{x}$	SD
Forb cover <sup>a</sup>		5	5	5	7
Grass cover	.06	10	9	9	6
Shrub cover					
Short, <40 cm	.69	14	10	14	10
Medium, 40–50 cm	.16	11	8	8	9
Tall, >50 cm	.59	4	6	3	5

<sup>a</sup>Because of significant plot type  $\times$  forb cover interaction ( $P = .02$ ), forb cover was tested individually by study area. Forb cover was greater ( $P > .05$ ) at broodless hen sites than at random locations at Jackass Creek but not at Hart Mountain.

important component of the diet of hens during summer (Patterson 1952:203, Wallestad et al. 1975). In Montana, Sage Grouse shifted from a diet of sagebrush to forbs in summer (Wallestad 1975). The change was attributed to availability and palatability of forbs. In cover types used at Hart Mountain, forb availability was relatively high, and broodless hens did not use sites within cover types on the basis of forb availability. These cover types (mountain big sagebrush, low sagebrush/fescue, meadow) were available at higher elevations (>1500 m) and presumably received greater amounts of precipitation, which may have increased forb production and delayed forb phenology compared with low-elevation sites. However, at Jackass Creek, where forb availability was low, sites used by broodless hens had greater forb cover than did random locations.

Big and low sagebrush cover types were used by broodless hens at both study areas.

Broodless hens in Nevada used open areas of low sagebrush for feeding and dense clumps or patches of big sagebrush for roosting (Klebenow 1972). In Montana, flocks of broodless hens were typically found in areas of dense sagebrush throughout summer (Wallestad 1975). Schoenberg (1982) reported that broodless hen sites in Colorado had greater sagebrush cover than did random locations. Our findings, however, indicated broodless hens did not select sites based on canopy cover of shrubs.

Our study revealed differences in chronology of summer movements and cover types used between broodless hens and hens with broods. Broodless hens gathered in flocks and remained separate from but in the vicinity of hens with broods during early summer. However, broodless hens moved to meadows earlier in summer and used a greater diversity of cover types than hens with broods. Several authors reported similar behavior and

TABLE 4. Vegetative characteristics (% cover) at random locations at Hart Mountain National Antelope Refuge and Jackass Creek study areas, Lake and Harney counties, Oregon, June and July 1990.

Characteristic	P value	Hart Mountain (n = 30)		Jackass Creek (n = 70)	
		$\bar{x}$	SD	$\bar{x}$	SD
Forb cover	.0001	12	9	2	3
Grass cover	.0001	13	9	7	3
Shrub cover					
Short, <40 cm	.0005	19	10	12	10
Medium, 40-80 cm	.25	6	12	9	5
Tall, >80 cm	.0006	1	1	4	6

chronology of summer movements by broodless hens (Batterson and Morse 1948, Dalke et al. 1963, Martin 1976, Connelly et al. 1988). Petersen (1980) reported that the early movement to meadows by broodless hens was related to nest loss and not desiccation of vegetation in uplands. Contrastingly, Schoenberg (1982) noted that summer movements by broodless hens and hens with broods occurred simultaneously and were probably a response to vegetation desiccation in sagebrush uplands.

Differences in summer habitat use between broodless hens and hens with broods may be attributed to specific dietary requirements of juvenile Sage Grouse. Juvenile Sage Grouse consume primarily forbs and insects during summer (Rasmussen and Griner 1938, Patterson 1952:201, Peterson 1970). Johnson and Boyce (1990) demonstrated that survival and growth of captive Sage Grouse chicks decreased as the quantity of insects in the diet decreased. Furthermore, hens with broods selected areas with less sagebrush (Klebenow 1969, Dunn and Braun 1986) and greater availability of forbs (Klebenow 1969, Peterson 1970, Wallestad 1971). Presumably, hens with broods remained in uplands until succulent forbs were no longer available; they then moved to meadows later in summer (Petersen 1980). Dietary needs of broodless hens might be less specific than those of hens with broods; as a consequence, broodless hens moved from uplands to meadows earlier in summer and used a greater diversity of cover types than hens with broods.

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#### LITERATURE CITED

- AMSTRUP, S. C. 1950. A radio-collar for game birds. *Journal of Wildlife Management* 44: 214-217.
- AVERY, T. E. 1977. Interpretation of aerial photographs. 3rd ed. Burgess Press, Minneapolis, Minnesota. 391 pp.
- BATTERSON, W. M., AND W. B. MORSE. 1948. Oregon Sage Grouse. Oregon Fauna Series 1. Oregon State Game Commission. 29 pp.
- BYERS, C. R., R. K. STEINHORST, AND P. R. KRAUSEMAN. 1954. Clarification of a technique for analysis of utilization-availability data. *Journal of Wildlife Management* 45: 1050-1053.
- CANFIELD, R. 1941. Application of the line interception method in sampling of range vegetation. *Journal of Forestry* 39: 356-394.
- CONNELLY, J. W., H. W. BROWERS, AND R. J. GALLS. 1988. Seasonal movements of Sage Grouse in southeastern Idaho. *Journal of Wildlife Management* 52: 116-122.
- DALKE, P. D., D. B. PYRAM, D. C. STANTON, J. E. CRAWFORD, AND E. F. SCHLATTERER. 1963. Ecology, productivity, and management of Sage Grouse in Idaho. *Journal of Wildlife Management* 27: S11-S11.
- DAUBENMIRE, R. F. 1959. A canopy-coverage method of vegetation analysis. *Northwest Science* 33: 224-227.
- DUNN, P. O., AND C. E. BRAUN. 1986. Summer habitat use by female and juvenile Sage Grouse. *Journal of Wildlife Management* 50: 225-235.
- EDMINSTER, F. C. 1954. American game birds of field and forest. Castle Books, New York. 490 pp.
- GIENSEN, K. M., T. J. SCHOENBERG, AND C. E. BLANK. 1952. Methods for trapping Sage Grouse in Colorado. *Wildlife Society Bulletin* 10: 224-231.
- GREGG, M. A. 1992. Use and selection of nesting habitat by Sage Grouse in Oregon. Unpublished master's thesis, Oregon State University, Corvallis. 46 pp.

- HITCHCOCK, C. L., AND A. CRONQUIST. 1957. Flora of the Pacific Northwest. 6th ed. University of Washington Press, Seattle. 730 pp.
- JOHNSON, D. A. 1980. The comparison of usage and availability measurements for evaluating preference. *Ecology* 61: 65-71.
- JOHNSON, G. D., AND M. S. BOYCE. 1990. Feeding trials with insects in the diet of Sage Grouse chicks. *Journal of Wildlife Management* 54: 89-91.
- KULBINOW, D. A. 1969. Sage Grouse nesting and brood habitat in Idaho. *Journal of Wildlife Management* 33: 649-662.
- \_\_\_\_\_. 1972. The habitat requirements of Sage Grouse and the role of fire in management. *Proceedings of the Tall Timbers Fire Ecology Conference* 12: 305-315.
- MARTIN, N. S. 1976. Life history and habitat requirements of Sage Grouse in relation to sagebrush treatment. *Proceedings of the Western Association State Game and Fish Commission* 56: 289-294.
- NEU, C. W., C. R. BYERS, AND J. M. PEEK. 1974. A technique for analysis of utilization data. *Journal of Wildlife Management* 38: 541-545.
- ODUM, E. P., AND E. J. KUENZLER. 1955. Measurement of territory and home range size in birds. *Auk* 72: 128-137.
- PATERSON, R. L. 1952. *The Sage Grouse of Wyoming*. Sage Books, Inc., Denver, Colorado. 341 pp.
- PETERSEN, B. E. 1980. Breeding and nesting of female Sage Grouse in North Park, Colorado. Unpublished master's thesis, Colorado State University, Fort Collins. 86 pp.
- PETERSON, J. G. 1970. The food habitats and summer distribution of juvenile Sage Grouse in central Montana. *Journal of Wildlife Management* 34: 147-155.
- RASMUSSEN, D. J., AND L. A. GRINER. 1938. Life history and management studies of the Sage Grouse in Utah, with special reference to nesting and feeding habits. *Transactions of the North American Wildlife Conference* 3: 852-864.
- SAS INSTITUTE, INC. 1989. *SAS/STAT user's guide, version 6*. Volumes 1 and 2. 4th ed. SAS Institute, Inc., Cary, North Carolina. 1686 pp.
- SCHOENBERG, T. J. 1982. Sage Grouse movements and habitat selection in North Park, Colorado. Unpublished master's thesis, Colorado State University, Fort Collins. 86 pp.
- Snedecor, G. W., and W. G. Cochran. 1967. *Statistical methods*. 6th ed. Iowa State University Press, Ames. 507 pp.
- WALLESTAD, R. O. 1971. Summer movements and habitat use by Sage Grouse broods in central Montana. *Journal of Wildlife Management* 35: 129-136.
- \_\_\_\_\_. 1975. Life history and habitat requirements of Sage Grouse in central Montana. Montana Department of Fish and Game, Helena. 65 pp.
- WALLESTAD, R. O., J. G. PETERSON, AND R. L. ENG. 1975. Foods of adult Sage Grouse in central Montana. *Journal of Wildlife Management* 39: 628-630.
- WALLESTAD, R. O., AND D. B. PYRAIL. 1974. Movement and nesting of Sage Grouse hens in central Montana. *Journal of Wildlife Management* 38: 630-633.

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